Task XIII.B: Systems and Equipment Malfunctions

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Lesson Overview

Objective

The student should develop knowledge of the elements related to emergency procedures and be able to explain the proper procedures for certain situations based on the ACS/PTS.

Reference

- Aircraft Flight Manual / Pilot’s Operating Handbook
- Airplane Flying Handbook (FAA-H-8083-3B, page(s))

Key Elements

1. Understand the Problem

2. Follow the Checklist
3. Safety of Those Onboard

Elements

1. Smoke, Fire, or both, during Ground or Flight Operations
2. Rough Running Engine or Partial Power Loss
3. Loss of Engine Oil Pressure
4. Fuel Starvation
5. Engine Overheat
6. Hydraulic Malfunction
7. Electrical Malfunction
8. Induction Icing
9. Door or Window Opening in Flight
10. Inoperative or “Runaway” Trim
11. Flap malfunction
12. Pressurization Malfunction

Equipment

1. White board and markers
2. References
3. iPad

Instructor Actions

1. Discuss lesson objectives
2. Present Lecture
3. Ask and Answer Questions
4. Assign homework

Student Actions

1. Participate in discussion
2. Take notes
3. Ask and respond to questions

Schedule

1. Discuss Objectives
2. Review material
3. Development
4. Conclusion

Completion Standards

The student has the ability to understand problems and why they may occur in the airplane. The student also can properly react to the emergency situations that have been discussed in a timely

manner.

Instructor Notes

Introduction

Attention

Wouldn’t it be fun to be flying one day and experience a problem that you have no idea how to deal with? Said Nobody… ever.

That’s why it’s important to understand your equipment and the proper procedures associated.

Overview

- Review Objectives and Elements/Key ideas

What

Systems and equipment malfunctions involves knowing how to handle problems that may occur in the airplane in order to provide as safe a flight as possible.

Why

The key to successful management of an emergency situation, and/or preventing a non-normal situation from progressing into a true emergency, is a thorough knowledge of, and adherence to, the necessary procedures.

Lesson Details

Aircraft are human constructions, so are subject to failure. There are numerous complex systems, and failures must be handled in a prompt and correct manner.

Smoke, Fire, or Both

Smoke and/or fire can happen during ground operations or in flight. It is essential that the source of the fire be identified as quickly as possible as the remediation is different depending upon the source. When a fire erupts there are two immediate demands. One is to attack the fire. The other imperative is to fly the airplane and get it on the ground as soon as possible.

Engine Fire

These fires are generally caused by a combustible substance coming into contact with a hot surface. An example emergency checklist for an engine fire is as follows.

Engine Fire Checklist

1. Fuel Valve : CLOSED
2. Cabin Heat : CLOSED

3. Fuel Pump : OFF
4. Airspeed : 74KIAS (*See POH for your plane!!*)

If the flames are extinguished, do not attempt to restart the engine. Execute an emergency landing. It is useful to remember that there may be severe structural damage from the fire, the airplane may still be on fire (even if it can't be seen) and might be susceptible to explosion, and that the airplane is expendable. The only thing of importance are the individuals onboard.

Electrical Fire

The most common indication of an electrical fire is the smell of burning insulation in the cabin. This is commonly due to either an overload condition, or an electrical short which triggers an overloaded circuit. An example emergency checklist for an electrical fire is as follows.

Electrical Fire Checklist

1. Master Switch : OFF
2. Avionics Master : OFF
3. Electrically Powered Equipment : OFF
4. Cabin Air : OPEN
5. Fire Extinguisher : Use if fire persists

Once the fire is extinguished it is possible, if necessary, to attempt to bring some electrical equipment back online. This should be done in a progressive and gradual manner checking, at each individual step along the way, that the electrical fire is not re-ignited. A potential strategy is as follows.

Restore Electrical

1. Circuit Breakers : PULL ALL
2. Circuit Breakers : PUSH BATTERY
3. Master Switch : BAT (only) ON
4. Circuit Breakers : PUSH GEN/ALT
5. Master Switch : ALL ON
6. Circuit Breakers : AVIONICS ON
7. Avionics Master : ON
8. Circuit Breakers : Activate individual systems as required
9. Radio : ON
10. Land ASAP

Attempt to identify the source of the fire, but if it can not be identified the master and

alternator/generator should be left turned off. Any materials that were ignited by the fire may continue to burn, even after the electrical source has been turned off. Land the aircraft as soon as possible, and remember that flying the airplane comes first, always.

Cabin Fires

These fires can result from careless smoking (does anyone smoke in an airplane any longer??), electrical systems failures, or heating system failures. An example checklist for a general cabin fire is as follows.

Cabin Fire Checklist

1. Master Switch : OFF
2. Cabin Air : OPEN
3. If smoke increases when the cabin air is opened, close it immediately as it is possible that there is a fire in the heating system or baggage are in smoke is entering through the cabin air system.
4. Cabin Heat : CLOSED
5. Fire Extinguisher : Use if fire persists
6. Land ASAP

Ground Smoke/Fire

The same failures that can happen in flight, can happen on the ground. The actions taken are identical, except that (a) troubleshooting can be left for later and done by an A&P, and (b) rather than the admonishment to land ASAP the engine (if running) should be shut down and all occupants should evacuate ASAP.

Rough Running Engine or Partial Power Loss

There are numerous reasons that an engine might run rough, or suffer partial power loss. An example emergency checklist for this situation is as follows.

Rough Engine / Power Loss Checklist

1. Mixture : FULL RICH
2. Alternate Air : OPEN
3. Fuel Valve : OPEN
4. Fuel Pump : ON
5. Ignition : CYCLE, L - BOTH - R - BOTH
6. Throttle : AT PRESENT POSITION
    a. If there is no improvement, reduce the throttle to minimum required power

7. Land ASAP if the condition persists (and maybe even if it clears)

Improper Engine Oil Pressure

Overly high oil pressure can simply be due to cold sluggish oil when the engine starts. Another is the possibility that oil passages might have become blocked. If cold allow the engine to warm, but if it is not cold reduce power and land ASAP. Low oil pressure can be for a number of reasons. It can be a broken pressure relief valve, insufficient oil, or failed bearings. In any cause the aircraft should be landed ASAP, and if appropriate (multi-engine aircraft only) the engine should be shut down and the prop feathered. Problems with oil pressure should cause the pilot to be ready to, at any moment, execute an emergency landing due to engine failure.

Fuel Starvation

The first indication of fuel starvation is a rough running engine. This failure can be due to blocked fuel lines, incorrectly positioned (or failed) fuel valve, or the simple scenario of not having any fuel left in the tank. An example emergency checklist for this condition follows.

Engine Overheating

The oil temperature gauge is the primary instrument for determining if the engine is overheating or not. There are a number of possible reasons for this condition, and the following table details the possible causes and the corrective action for each.

Possible Causes	**Corrective Action**
Low Oil	Reduce Power and Land
Oil Congealed in Cooler	Reduce Power and Land, Preheat Engine
Inadequate Engine Cooling	Reduce Power, Increase AS
Detonation or Preignition	Check Cylinder Head Temps/Enrich Mixture/Reduce MP
Obstruction in the Oil Cooler	Reduce Power. Land ASAP
Damaged or Improper Baffle Seals	Reduce Power. Land ASAP
Defective Gauge	Reduce Power. Land ASAP

Hydraulic Malfunction

Most small aircraft have no hydraulic systems, other than the brakes. Others have extensive hydraulics (Navion, for example) and failures usually impact the gear system. If the landing gear is operated via hydraulics then there is some alternative means of extending the gear provided. Use that alternative extension mechanism if needed.

Electrical Malfunction

The generator/alternator is the source for most electrical systems failures. The most immediate indication is via the ammeter. Once the generator/alternator fails then the only remaining source of electrical energy is the battery, which will hold the system up for some time, but will eventually be depleted.

Different systems in the aircraft use electrical energy at wildly different levels. Most modern avionics use a trivial amount of electricity, whereas systems such as electrically driven flaps and landing gear use much much more. Activating one of these motor-driven systems on an already depleted battery can result in an immediate total loss of electrical power.

In the event of a generator/alternator failure turn off all but the most necessary equipment (load shed). Notify ATC immediately and request vectors for a landing at the nearest airport. Expect to make a no-flap landing and a manual gear extension if the aircraft has electrically driven flaps and/or electrically driven gear.

There are various electrical failure scenarios, and some example checklists for the various scenarios are included below.

Total Electrical Failure Checklist

1. Battery Circuit Breaker : RESET (if tripped)
2. Master Switch : CHECK ON
3. Master Switch : OFF (if power not restored)
4. Land ASAP

Generator/Alternator Failure Checklist

1. Master Switch : CYCLE
2. Gen/Alt Circuit Breaker : RESET (if tripped)
3. Gen/Alt Control Breaker : RESET (if tripped)
4. If Gen/Alt can’t be brought back online, shed load and land as soon as practicable.

Low Voltage Indication (On Ground) Checklist

1. Engine RPM : INCREASE until needle in green (should occur before 1100 RPM)
2. Shed LOAD : Switch OFF consumers until the needle in green
3. If needle remains in the yellow, and the ammeter is indicating discharge, discontinue the flight

Low Voltage Indication (In Flight) Checklist

1. Shed LOAD : Switch OFF consumers until the needle in green

2. If needle remains in the yellow, Land ASAP

Induction Icing

As air is ingested through the engine intakes, the moisture can freeze inside the induction system. This can reduce the flow of combustible air to the engine. It is possible for ice to form on the exterior of the aircraft, as well, and block the air intake. The only remedy is to use an alternate air source to bypass the blockage.

Icing Checklist

1. Leave the area of icing ASAP
2. Continue to move the control surfaces to maintain mobility
3. Alternate Air : ON
4. Increase RPM to avoid icing of prop blades
5. Cabin Heat : ON DEFROST (if available)

Door or Window Opening in Flight

This is not an uncommon occurrence in light aircraft, given the lightweight construction techniques used. It is rarely an emergency. However, it can be extremely disconcerting and can produce chaotic winds and loud noise in the cockpit. The biggest risk is generally one of the pilot being distracted by the event and failing to fly the aircraft. The steps to take when this occurs is as follows.

Door/Window Open

1. **First, fly the plane. This isn't an emergency.**
2. Do not rush to land the plane if the door opens on takeoff
3. Climb to normal pattern altitude and make a normal landing.
4. Leave the door alone, land, and close it then.
5. Most doors won't open beyond a certain point, then they are held in place by the aerodynamic slipstream
6. A slip toward the door may open it wider, and a slip away from the door may push it more closed.

Inoperative or Runaway Trim

The failure of the trim often is at one of two extremes. It either fails to work at all, or sticks in a "runaway" state which will cause it to run to the far end of the trim travel. A failed trim is an annoyance, but a runaway trim can cause controllability problems. Steps to take if this occurs are as follows.

Failed or Runway Trim

1. First, fly the plane. Maintain control.
2. If a runaway, pull the trim breaker to stop movement
3. Check if the trim switch has been depressed and stuck in position
4. If a failed trim, fly the plane and land as soon as practicable

Flap Malfunction

There are two common flap failure modes. One is a simple failure to operate. This simply requires a no-flap landing, with the repercussions of this being specific to each aircraft type. Generally this will result in a longer landing distance, a more nose-high approach, a slightly higher approach speed, and a wider/longer pattern to help lose altitude without diving to do so. More "float" on landing can be expected.

The other failure is the asymmetric deployment of flaps (also known as "split flaps"). This is where the flap on one side deploys, and the other does not. This will result in a pronounced (sometimes extreme) roll in the direction of the side with the least amount of flap deployed.

Split flaps are countered with opposite aileron. The yaw caused by the additional drag on the extended flap side will require opposite rudder (resulting in a cross-controlled condition). It may take almost full opposite aileron to counter the rolling tendency.

In this condition do not attempt to land with a cross-wind from the side with the deployed flap, as the aircraft may lose aileron travel and not be able to counter the cross-wind. Be aware that the stall speed for the two wings (one with a flap down, and one without) can be quite different. Therefore the approach and landing should be done at a speed higher than normal.

Pressurization Malfunction

There is little to do in the event of a pressurization failure. If the aircraft is at an altitude where pressurization is required, descending is the only option. Be aware of hypoxia and be prepared to address that possibility if needed (i.e. consider using supplemental oxygen until at a lower altitude). Be aware that the loss of pressurization may be due to a decompression failure, as well as other pressurization systems failures.

Common Errors

- Improper airspeed control
- Poor judgment in the selection of an emergency landing area
- Failure to estimate the approximate wind speed and direction
- Failure to fly the most suitable pattern for existing situation
- Failure to accomplish the emergency checklist

- Undershooting or overshooting selected emergency landing area

Conclusion

Understanding different emergencies and how to deal with them is obviously important as you will always be prepared and be able to react quickly in the event one of these emergencies occurs.

ACS Requirements

CFI PTS Standard

To determine that the applicant exhibits instructional knowledge of at least five (5) of the equipment malfunctions, appropriate to the airplane used for the practical test by describing recommended pilot action for

1. Smoke, fire, or both, during ground or flight operations.
2. Rough running engine, or partial power loss.
3. Loss of engine oil pressure.
4. Fuel starvation.
5. Engine overheat.
6. Hydraulic malfunction.
7. Electrical malfunction.
8. Carburetor or induction icing.
9. Door or window opening in flight.
10. Inoperative or “runaway” trim.
11. Landing gear or flap malfunction.
12. Pressurization malfunction.